United States Patent [19]

Katsumata et al.

[11] **4,193,385**

[45] **Mar. 18, 1980**

[54] **ENGINE STOPPING DEVICE**

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Oct. 5, 1976	[JP]	Japan	51-133298[U]
Oct. 5, 1976	[JP]	Japan	51-133299[U]
Oct. 5, 1976	[JP]	Japan	51-133300[U]
Oct. 5, 1976	[JP]	Japan	51-133301[U]
Oct. 5, 1976	[JP]	Japan	51-133302[U]

[51] **Int. Cl.**[2] **F02B 77/08**

[52] **U.S. Cl.** ..... **123/198 DC;** 123/148 S

[58] **Field of Search** ..... 123/198 DC, 198 D, 148 S, 123/148 CA

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,703,889	11/1972	Bodig et al.	123/198 DC
3,863,616	2/1975	Wood	123/198 DC
3,960,128	6/1976	Anderson	123/198 DC
3,964,461	6/1976	Wesemeyer et al.	123/198 DC
4,036,200	7/1977	Kuehn	123/198 DC
4,073,279	2/1978	Fox	123/198 DC

Primary Examiner—Ira S. Lazarus

Attorney, Agent, or Firm—Pearne, Gordon, Sessions

[57] **ABSTRACT**

An engine stopping device for stopping an internal combustion engine provided with an ignition system energized by a generator driven by the engine. The stopping device comprises a switch for making ineffective at least one of the elements of the ignition system, an actuator for actuating the switch into the operated state and a retaining device for retaining the switch in the operated state until the engine is brought to a standstill. Although it takes time for the engine to be brought to a standstill, the operator just has to give the actuator one touch operation, such as pressing a button, and may release the actuator before the standstill. Subsequent starting of the engine requires no extra operation.

5 Claims, 21 Drawing Figures

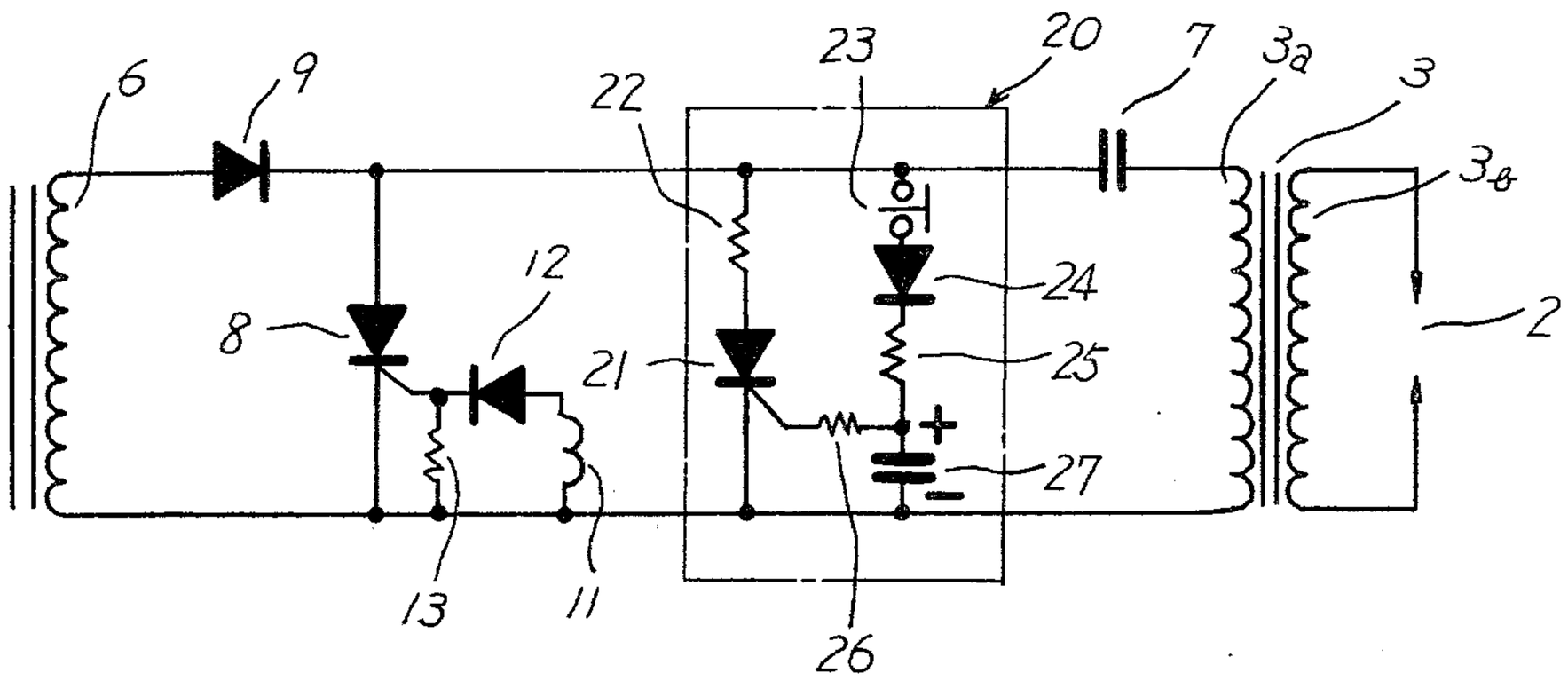


FIG.1

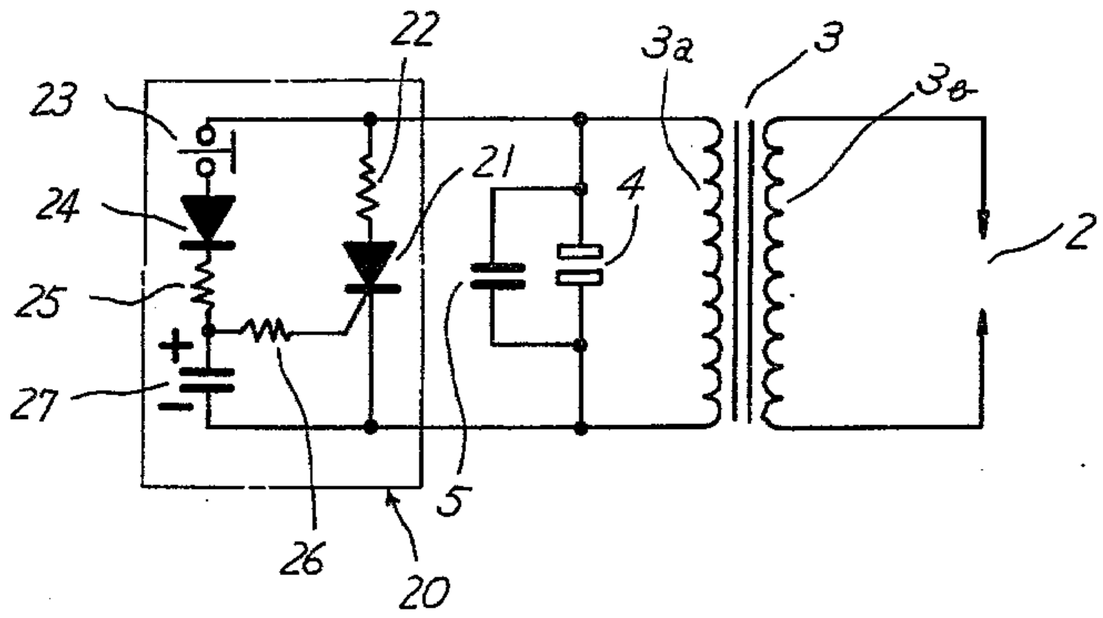


FIG.2

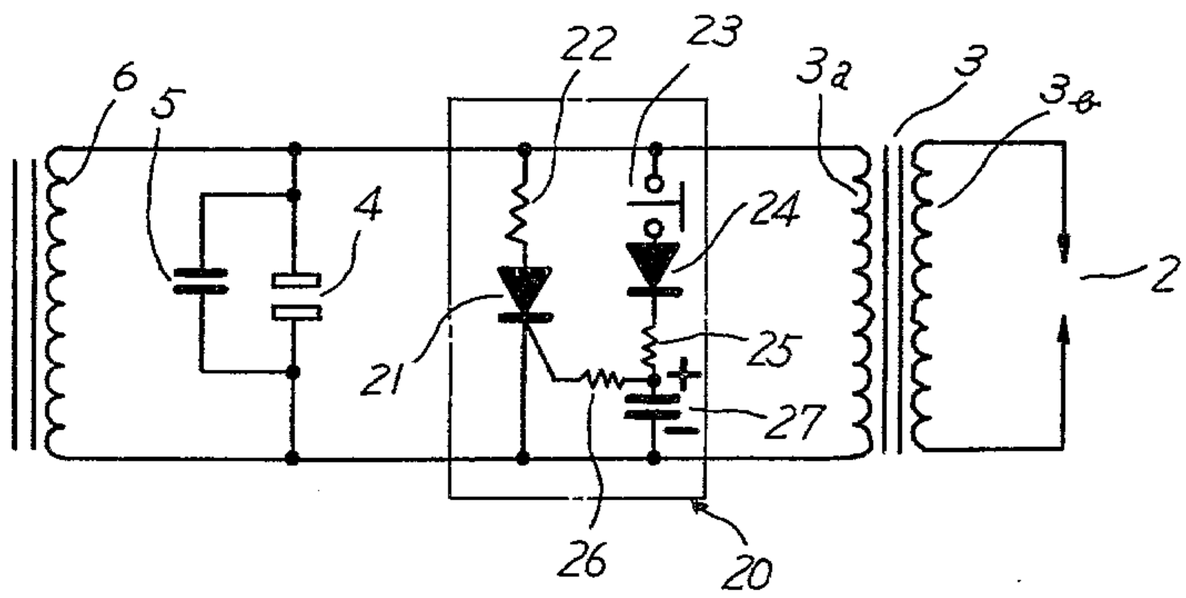


FIG.3

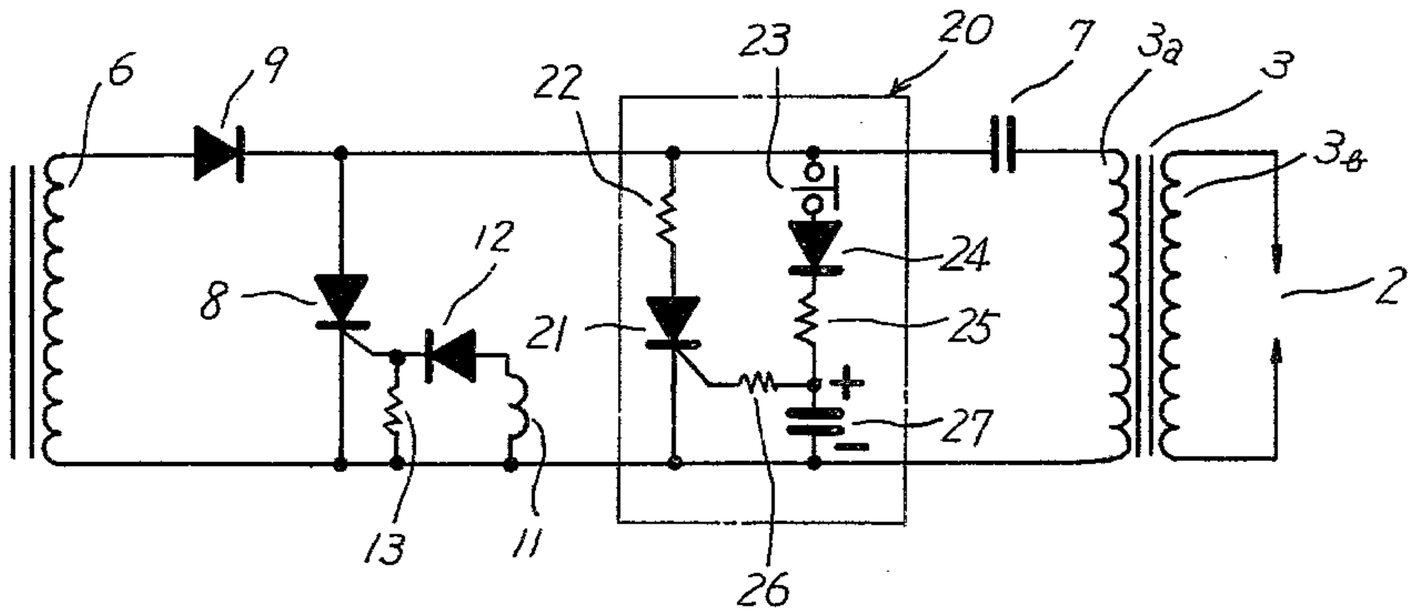


FIG.4

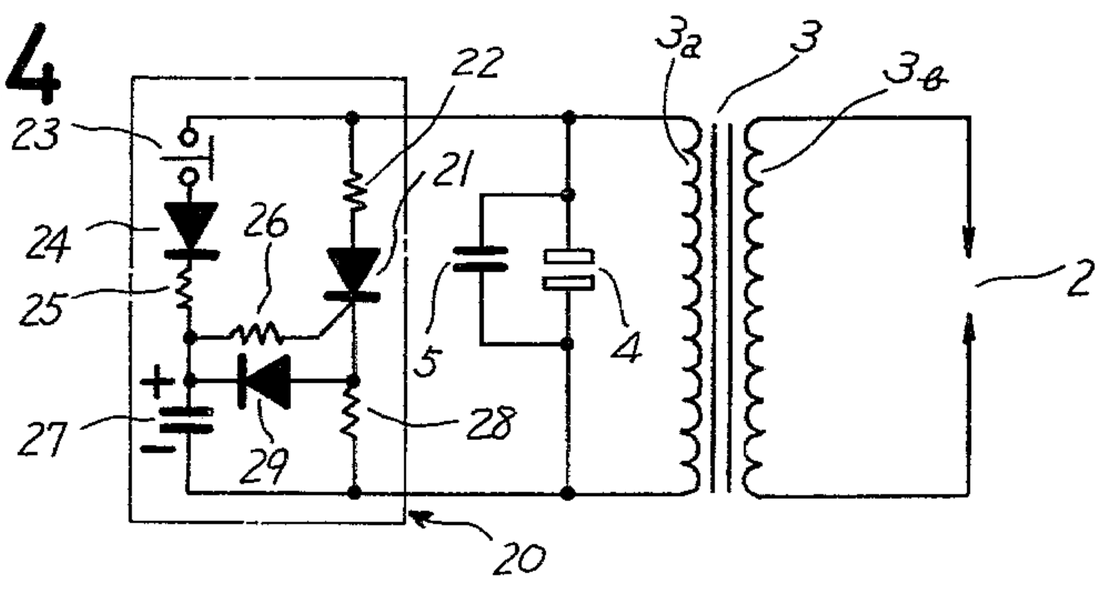


FIG.5

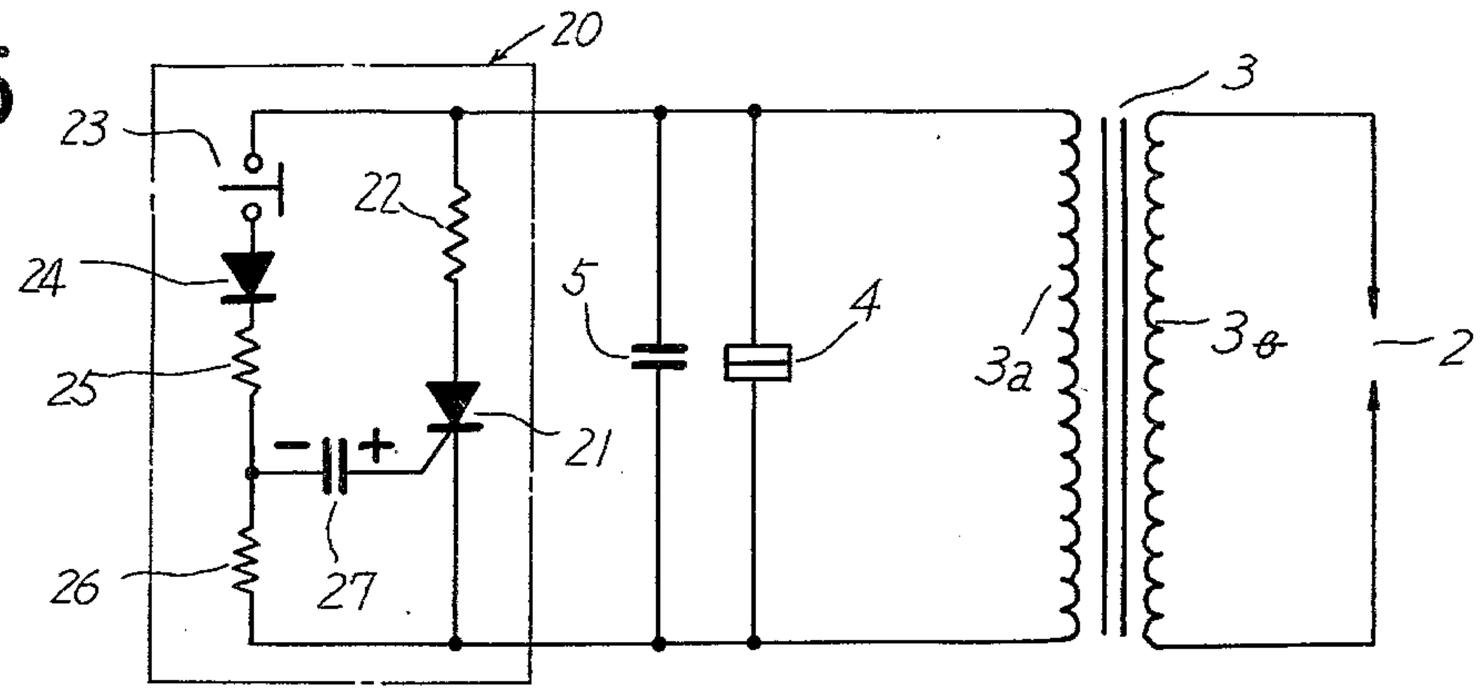


FIG.6

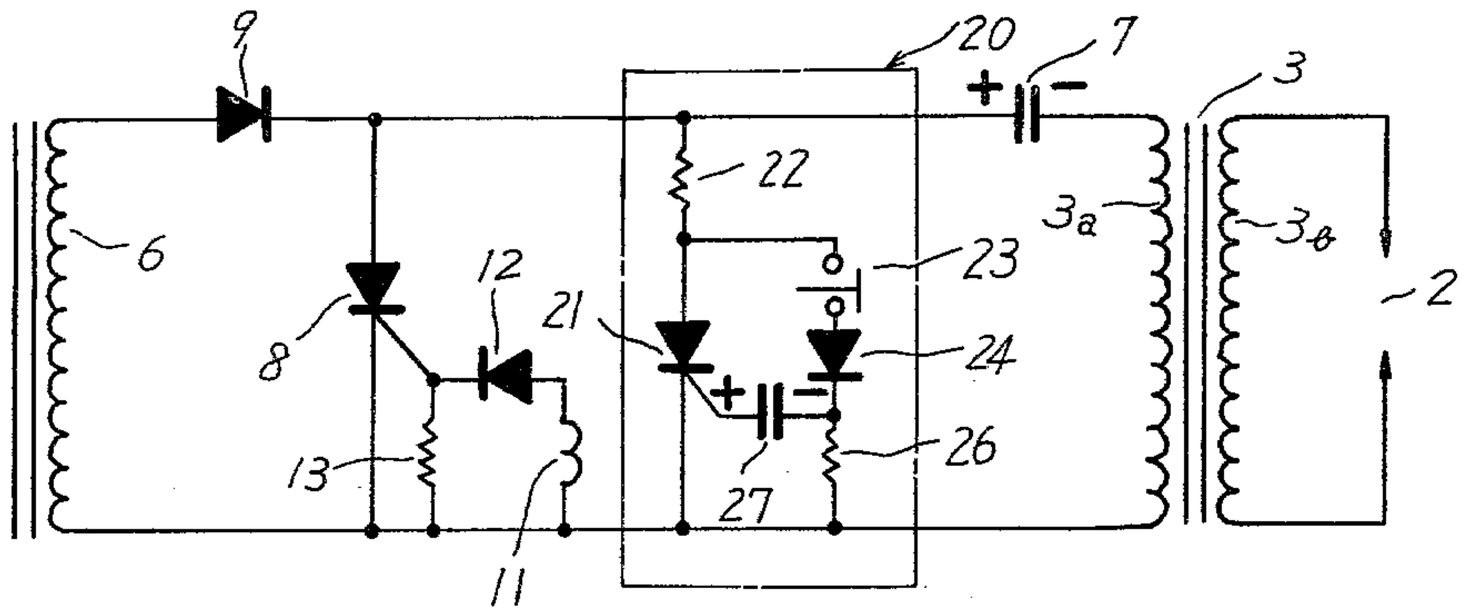


FIG.7

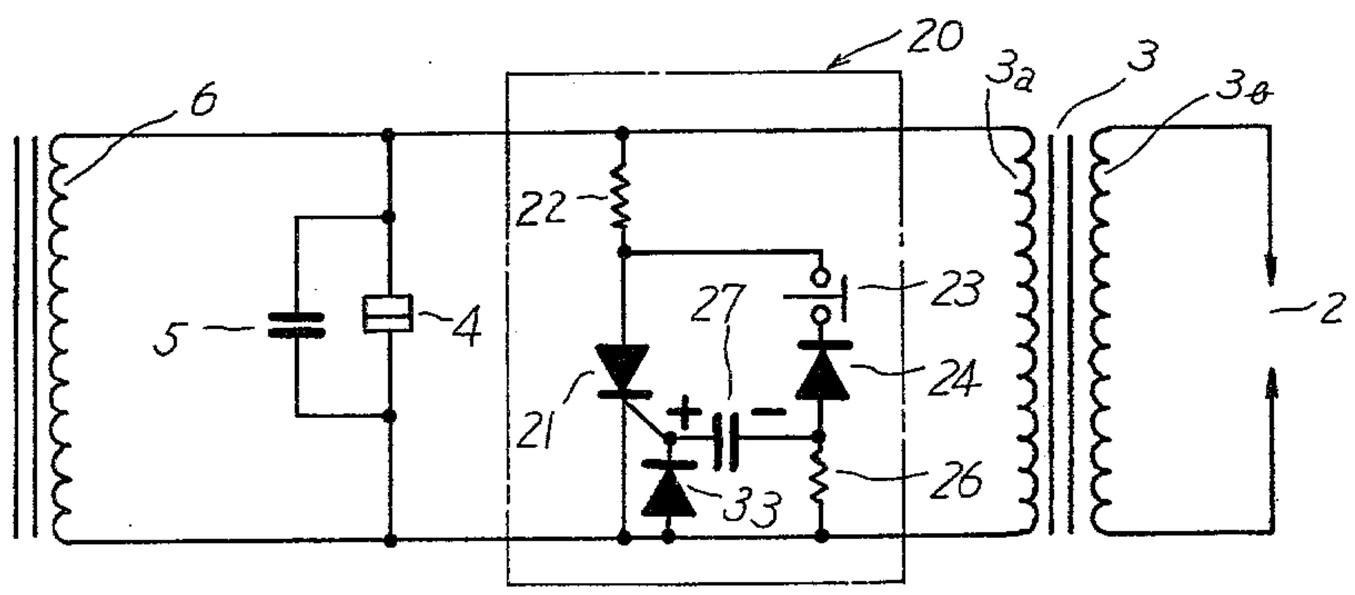


FIG.8

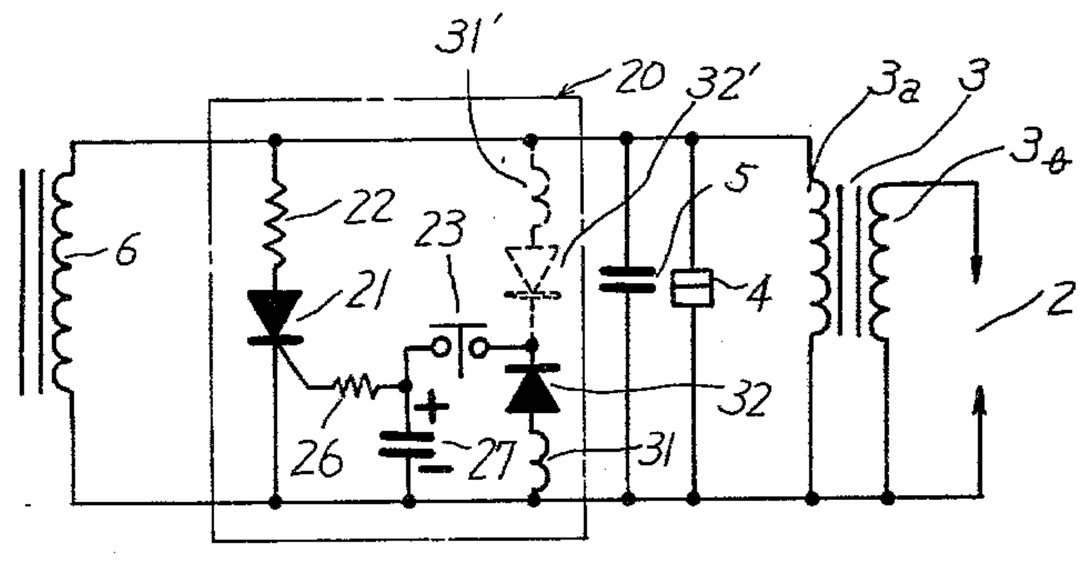


FIG.9

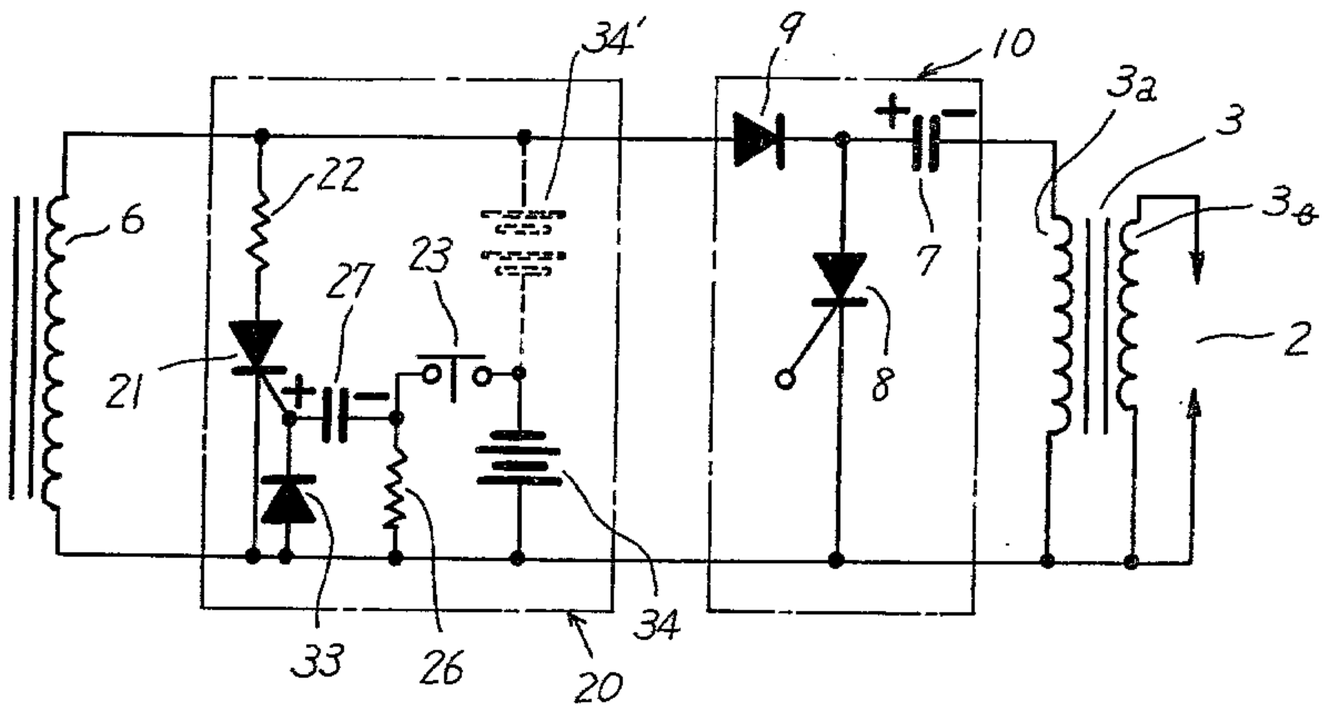
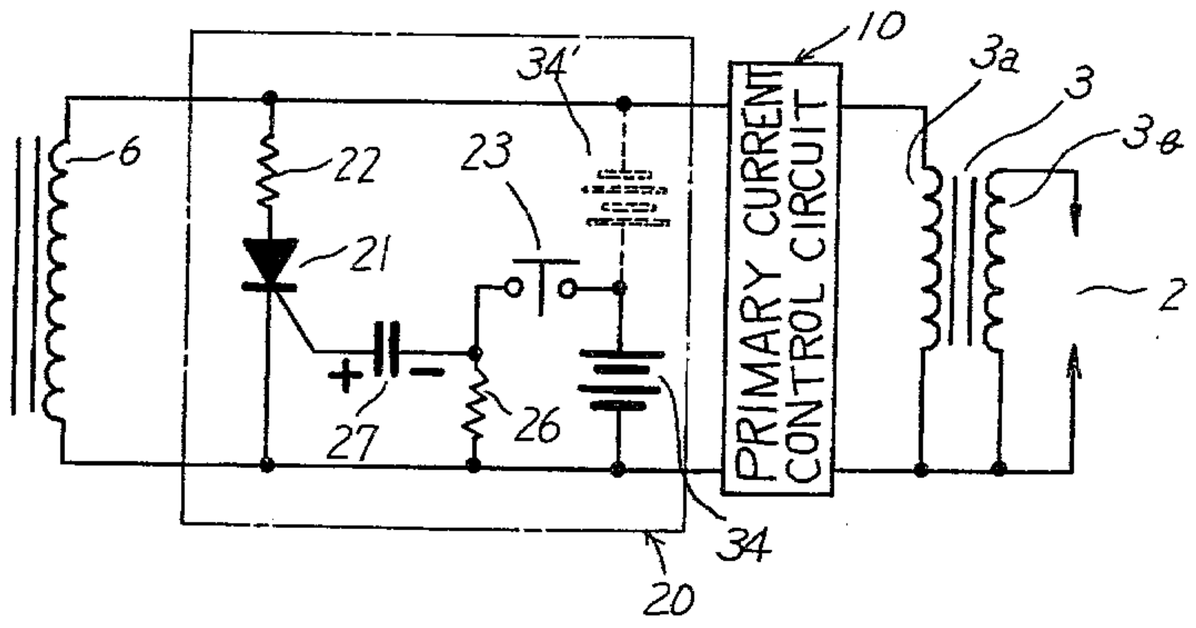


FIG.10



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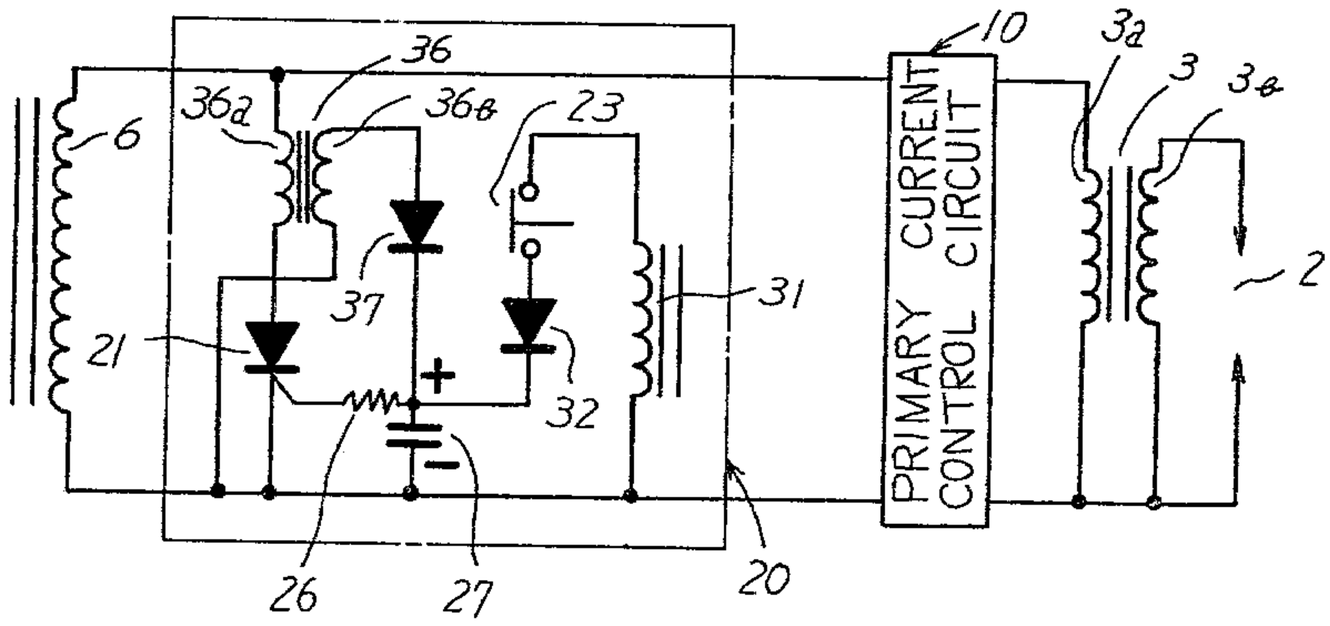


FIG.12

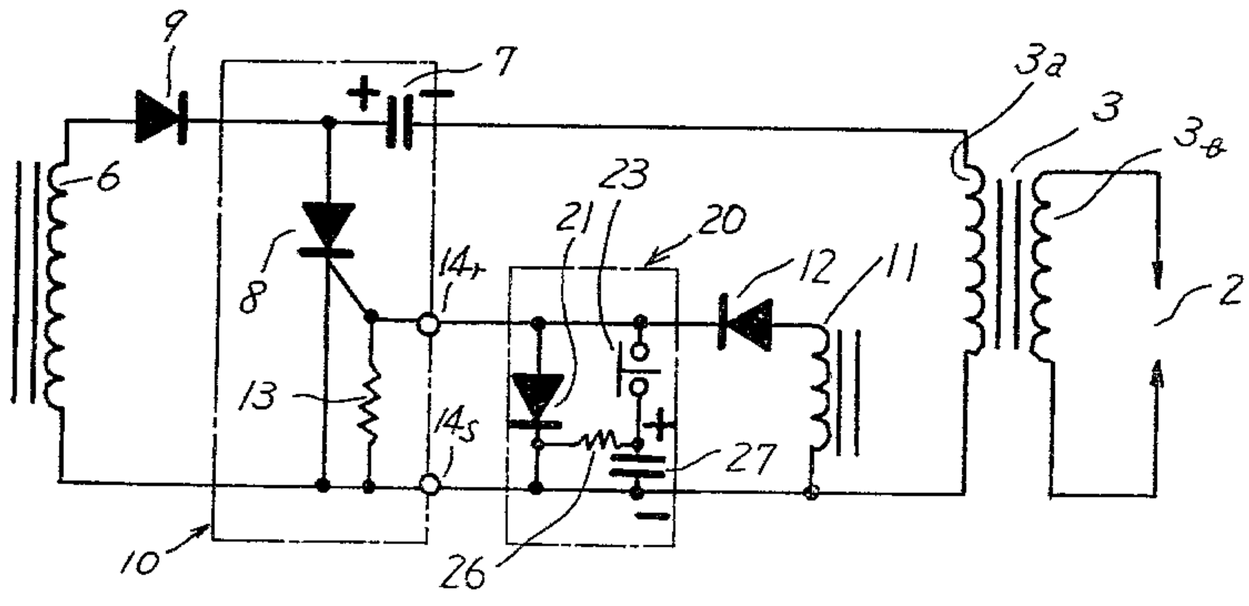


FIG.13

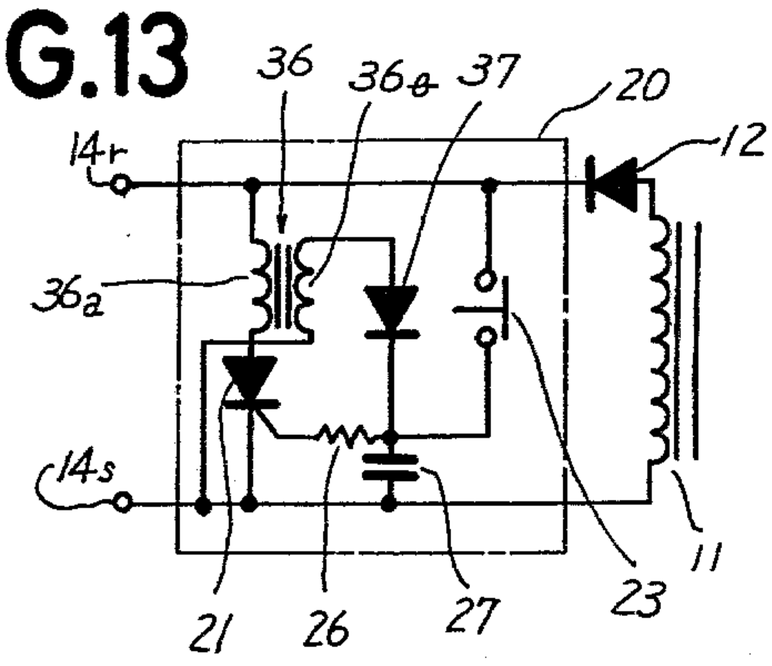


FIG.14

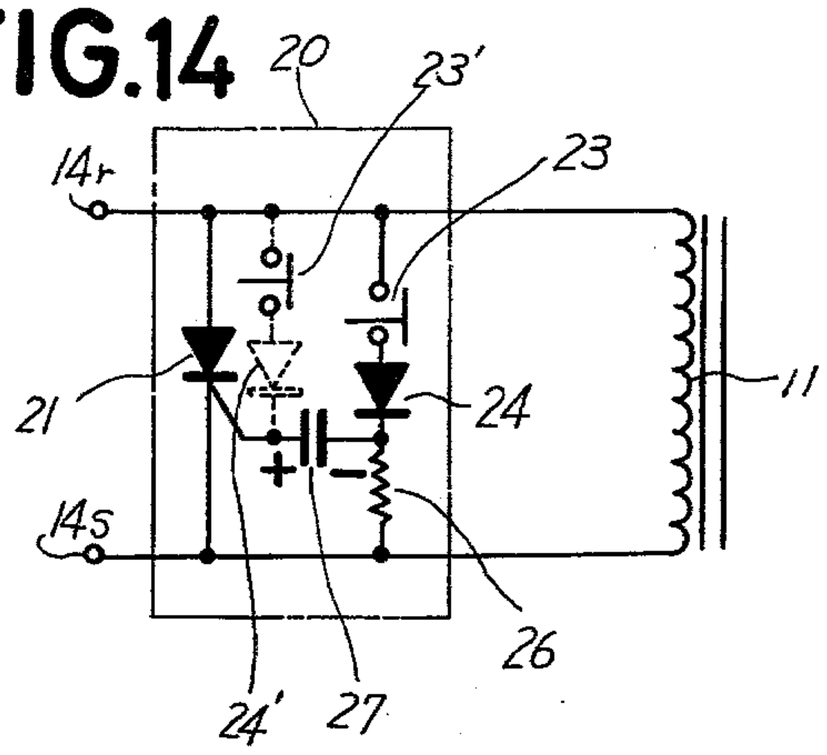


FIG.15

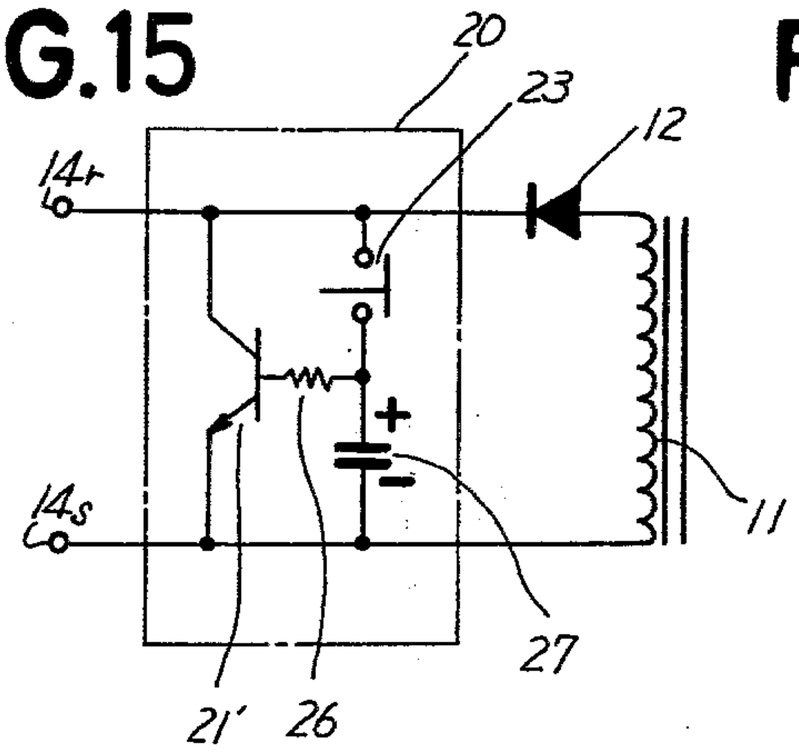


FIG.16

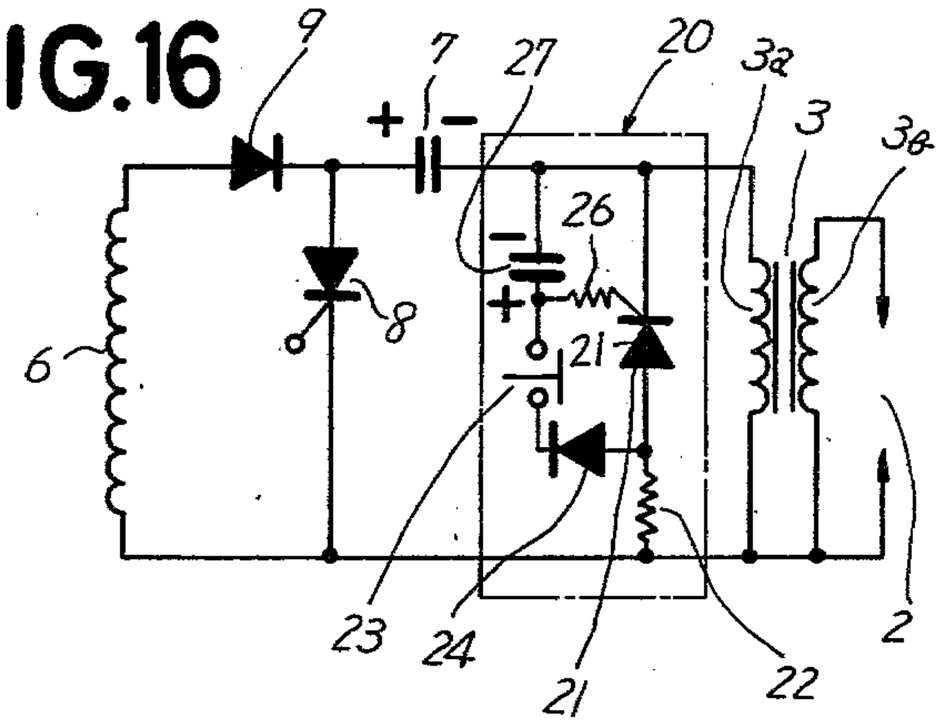


FIG.17

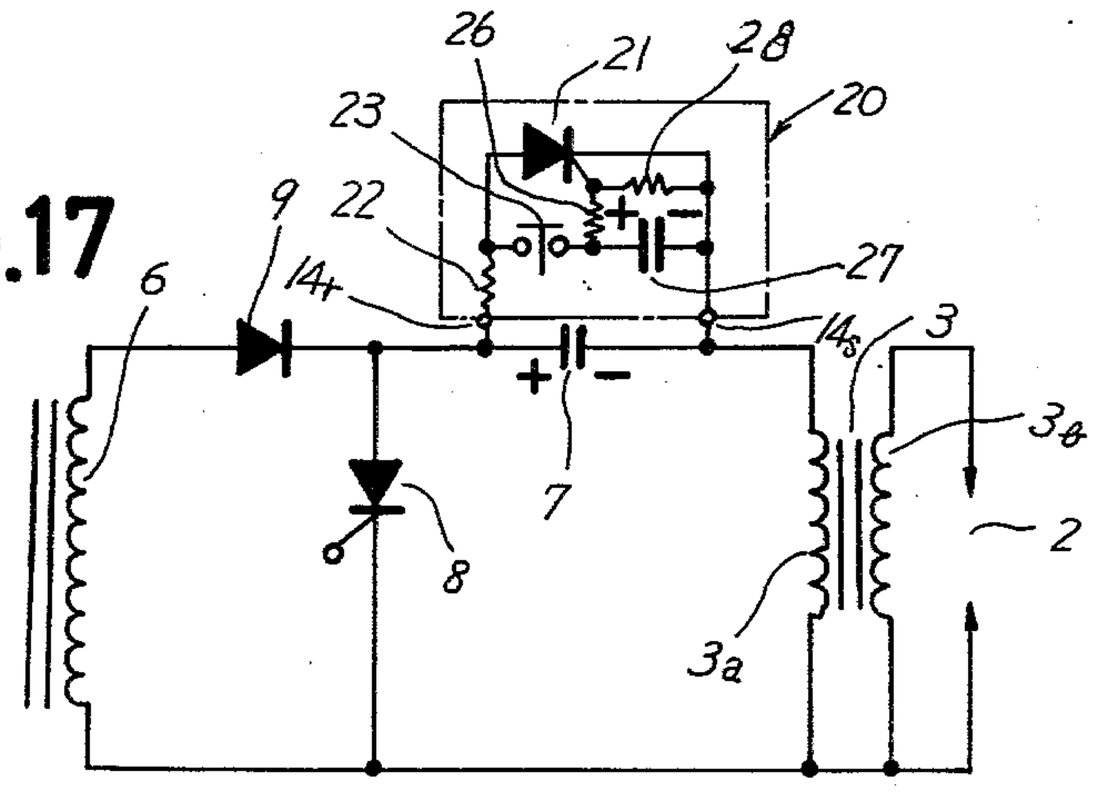


FIG.18

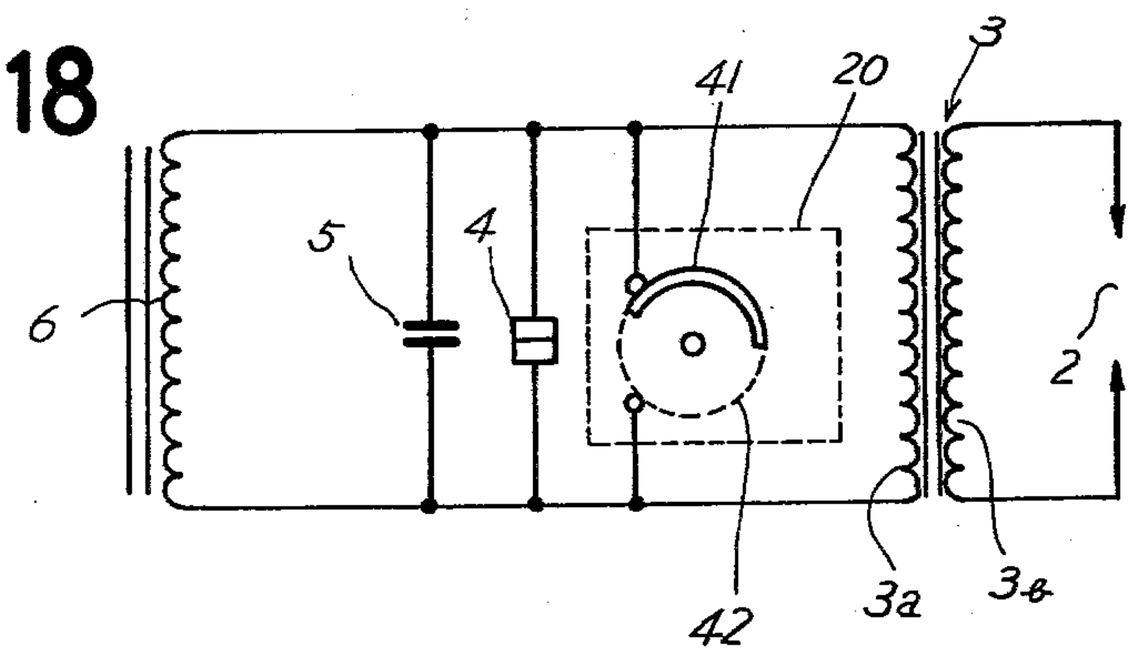


FIG.19

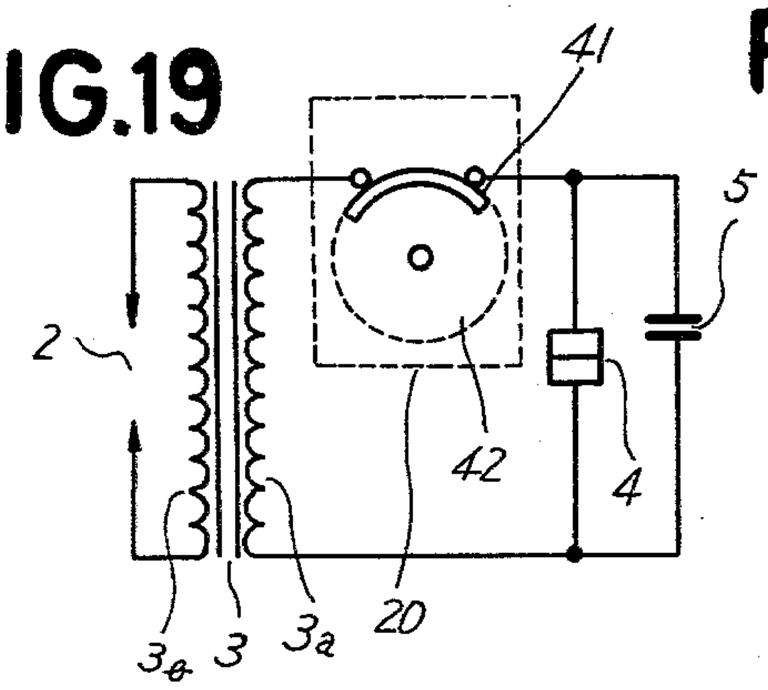


FIG.20

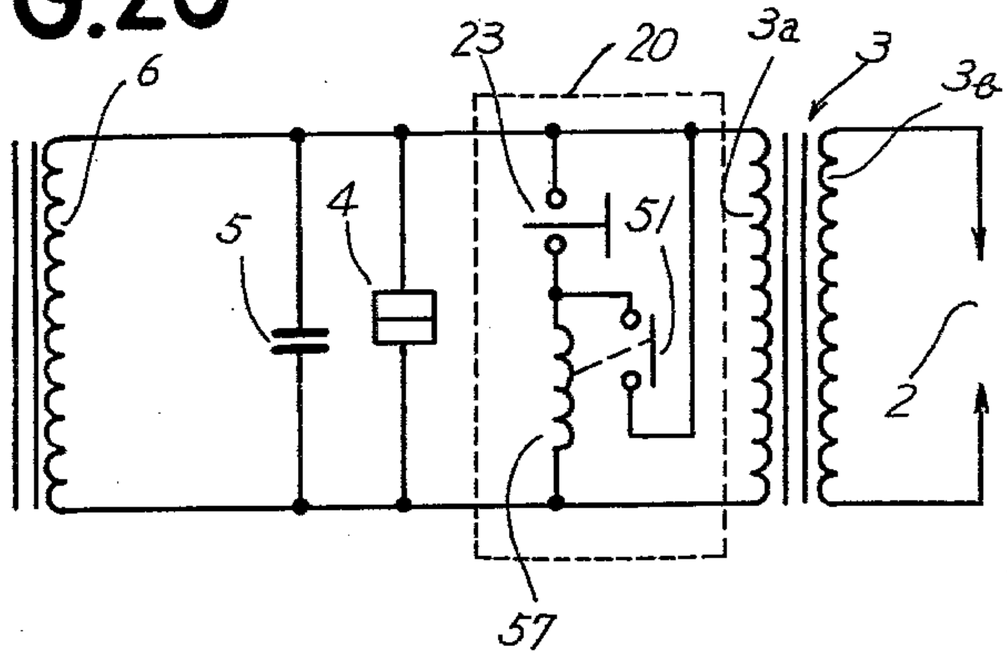
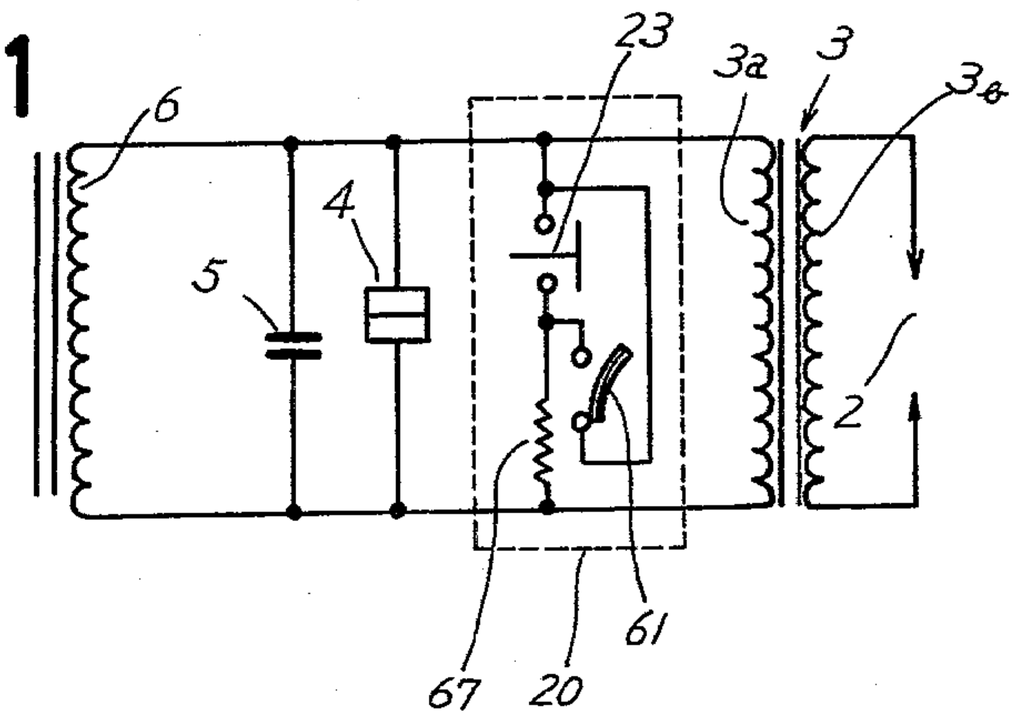


FIG.21



ENGINE STOPPING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to an engine stopping device for stopping an internal combustion engine provided with an ignition system energized by a generator driven by the engine.

Internal combustion engines for use in a machine such as a small-sized generator or an agricultural machine which is not provided with batteries employ a magneto generator as a power source for the ignition circuit. In these machines, simplicity of construction is indispensable and a key switch, as in a batteries-provided engine, is not employed. The ignition circuit is normally connected with the magneto generator which act as a power source when rotated. The magneto generator, usually mounted on the crank shaft of the engine, is started by means of "rope start" or "kick start".

It is necessary to provide a special means for stopping the engine. Conventionally, a push-button switch is connected across the armature winding of the magneto generator and is pressed, when the engine is to be stopped, to short-circuit the output of the magneto generator. Because of the inertia of the engine and the magneto generator, the engine does not come to a standstill immediately and it takes more than a few seconds. If the push-button switch is released before the engine comes to a stand-still, the engine may be re-started, which may be dangerous. Particularly, where the engine is heated to a high temperature, the engine is easier to re-start even if the push-button is released when the engine is decelerated to a considerably low speed. The above-described arrangement thus requires burdensome operation to keep pressing the push-button for more than about five seconds. Another conventional arrangement employs a snap switch in place of the push-button switch. But with this arrangement, the operator sometimes tries to start the engine while the snap switch is left closed: the result is that the ignition plug is wet with fuel and starting of the engine is made even more difficult.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an engine stopping device for stopping an internal combustion engine provided with an ignition system energized by a generator driven by the engine, the stopping device being capable of reliable stoppage of the engine and causes no inconvenience at the start of the engine.

An engine stopping device according to the invention comprises a stopping switch adapted to make ineffective at least one of the elements forming the ignition system. The element made ineffective may be the ignition power source, such as the exciter coil provided in the magneto generator, or the primary winding of the ignition coil. With an ignition system comprising a breaker for controlling the ignition coil primary current, the breaker may be made ineffective by the switch of the stopping device. With an ignition system comprising a semiconductor switch for controlling the ignition coil primary current, the semiconductor switch or a control signal source controlling the semiconductor switch may be made ineffective. Still alternatively, with an ignition system comprising a capacitor for supplying a discharging current through the ignition coil primary, the capacitor may be made ineffective. To make ineffective the element of the ignition system, the stopping switch of the stopping device is adapted to provide a bypass in shunt with the element to be made ineffective when the engine is to be stopped. Alternatively, the stopping switch of the stopping device is connected in series with the element to be made ineffective, and is opened when the engine is to be stopped.

The engine stopping device may further comprise an actuator for actuating the stopping switching into conductive state when the engine stopping operation is initiated. The engine stopping operation is initiated, for instance, by means of manually operating the actuator to the operated position. The actuator may preferably comprise a self-returning switch, such as a self-returning push-button switch. With the self-returning character of the actuator, there will be no trouble in the starting which may be subsequently conducted. The engine stopping device may further comprise a retaining device for retaining the stopping switch in the operated position until the engine is brought to a standstill, even after the actuator has been released. The retaining device may comprise a capacitor adapted to be charged when the stopping switch is conductive and to provide a signal for holding the stopping switch in conductive state. The capacitor may be further connected to be charged when the actuator is operated, so that initial triggering as well as successive triggering of the stopping switch is achieved by the voltage across the capacitor. In order for the capacitor to be charged when the stopping switch is conductive, the capacitor may be connected across a resistor connected in series with the switch. Where the stopping switch comprises a thyristor, the capacitor may be connected across the gate and cathode of the thyristor so that it is charged by the voltage drop across the gate and cathode of the thyristor. The capacitor may still alternatively be adapted to be charged by a secondary of a transformer whose primary is connected in series with the stopping switch. The power source for charging the capacitor may comprise a voltage across the element to be bypassed, or it may be provided separately.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will be apparent from the following detailed description of the embodiments taken in conjunction with the accompanying drawings, in which;

FIGS. 1 through 21 show various embodiments of the engine stopping device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to FIG. 1, there is shown an embodiment of an engine stopping device generally indicated by numeral 20 which is adapted to stop operation of the ignition system and hence the engine, not shown, ignited by an ignition plug 2. The ignition system comprises an ignition coil 3 including a primary winding 3*a* and a secondary winding 3*b* across which the ignition plug 2 is connected. The ignition coil 3 of this embodiment is provided in a magneto generator to act as an ignition power source as well. A breaker 4 is connected across the primary winding 3*a* and is made to close in advance of the ignition timing and to open at the ignition timing, thereby interrupting the primary current which in turn induces a high voltage in

the secondary. A capacitor **5** is connected in parallel with the breaker **4** to prevent the spark in the breaker.

The engine stopping device **20** comprises a stopping switch which is shown to be a thyristor **21** having its anode connected through a current limiting resistor **22** to a first end of the primary winding **3***a* and having its cathode connected directly to the second end of the primary winding **3***a*. The stopping device **20** further comprises a push-button switch **23** employed as a manually-operated self-returning switch. A diode **24** and resistors **25** and **26** are connected in series with the push-button switch **23**, and this series circuit is adapted to couple the first end of the primary winding **3***a* and the gate of the thyristor **21**. A capacitor **27** is provided to serve as means for retaining the conductive state of the thyristor **21** and has one of its terminals connected to the junction between the resistors **25** and **26** and the other terminal connected to the cathode of the thyristor **21**.

When stoppage of the engine is desired, the push-button switch is manually closed, the capacitor **27** is charged into a polarity as indicated by "+" and "−" through a path including the push-button switch **23**, the diode **24** and the resistor **25** while the output of the power source, namely the primary winding **3***a*, is, in its positive half cycle, that is positive to the anode of the thyristor **21**. As the capacitor **27** is charged the thyristor **21** is triggered and becomes conductive to permit a current to flow therethrough. This will make ineffective the operation of the breaker **4** since the variation of the primary current is reduced and the secondary voltage becomes insufficient.

As long as a current is flowing through the thyristor **21**, a voltage drop of about 0.6–1.0 V appears across the gate and the cathode. This voltage drop is applied across the capacitor **27** through the resistor **26** and the capacitor **27** is thereby charged to a voltage of about 0.6–1.0 V.

As the output voltage of the primary winding **3***a* goes negative the thyristor **21** is turned off. Gradual discharge of the capacitor **27** takes place, but the voltage across the capacitor **27** remains sufficient until the subsequent positive half cycle.

As the subsequent positive half cycle begins, with the voltage across the capacitor **27** being kept applied across the gate and cathode of the thyristor **21**, the thyristor is turned on again. And the ignition operation of the ignition system is prevented.

Ignition-preventing operation of the engine stopping device is repeated until the engine is brought to a standstill and the primary winding **3***a* no longer generates an output voltage.

After the engine has come to a standstill the capacitor **27** is gradually discharged through the resistor **26** and the gate and cathode of the thyristor **21**. With the capacitor **27** discharged, the next starting of the engine will be accomplished without trouble.

In the aforesaid construction, the voltage across the capacitor **27** charged by the voltage drop across the gate and cathode of the thyristor **21** is as low as 0.6–1.0 V. But, where a thyristor having a high gate sensitivity is adopted, the thyristor can be turned by a gate-cathode voltage of about 0.2–0.4 V, so that there will be no failure of turn-on.

FIG. **2** shows the engine stopping device similar to that of FIG. **1** and adapted to an ignition system incorporating a separate power source **6**, shown to be an exciter coil provided in a magneto generator and connected across the primary winding **3***a*. The rest of the construction is similar to that of FIG. **1**. While the exciter coil produces a positive output, the breaker **4** is closed in advance of the ignition timing, and is opened at the ignition timing to interrupt the short-circuit current having been flowing therethrough. This in turns causes a large current to flow through the primary winding **3***a*. The engine stopping device **20** operates in a manner substantially similar to that explained with reference to FIG. **1**.

FIG. **3** shows an engine stopping device similar to that of FIG. **1** or FIG. **2** adapted to a capacitor discharge ignition system wherein a capacitor **7** is connected to be charged by an exciter coil **6** through a diode **9** and to be discharged through the primary winding **3***a* and a thyristor **8** when the thyristor is turned on at the ignition timing by a pulse generator **11** supplying a trigger pulse at the ignition timing through a diode **12** to the thyristor's gate coupled by a resistor **13** to the cathode of the thyristor. The thyristor **21** of the engine stopping device **20** is connected through the resistor **22** across the ignition power source which consists of the exciter coil **6** and the diode **9**. The resistor **26** and the capacitor **27** are connected in series connection, and the series circuit is connected across the gate and the cathode of the thyristor **21**. The push-button switch **23** is adapted to couple the gate of the thyristor **21** and the ignition power source so that a trigger signal is supplied to the thyristor when the push-button switch **23** is closed. In this embodiment, the push-button switch **23** is connected in series with the diode **24** and resistors **25** and **26**, and this series circuit couples the cathode of the diode **9** and the gate of the thyristor **21**.

FIG. **4** shows another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **1**. The engine stopping device **20** of this embodiment is similar to that of FIG. **1**, **2** or **3**, except that a diode **29** is provided to have its anode connected to the cathode of the thyristor **21** and to have its cathode connected to the junction between the resistor **25** and one terminal of the capacitor **27**, and that a resistor **28** is also provided to have one end connected to the cathode of the thyristor **21** and to have the other end connected to the other terminal of the capacitor. **27**. When the thyristor **21** is conductive the capacitor **27** is charged by the voltage across the resistor **28** through the diode **29** to a voltage dependent on the resistance of the resistor **28**. With a sufficient charging voltage, turn-on of the thyristor **21** is ensured. The engine stopping device shown in FIG. **4** may be incorporated in any of the ignition systems shown in FIGS. **1–3**.

In the various embodiments described above, the diode **24** may be omitted. It is also noted that the current limiting resistor **22** may be omitted if the thyristor **21** has a sufficient current capacity or the ignition power source, the primary winding **3***a* or the exciter coil **6** has a sufficient current limiting impedance.

FIG. **5** shows still another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **1**. The engine stopping device of this embodiment is similar to that of FIG. **1** except that the positioning of the resistor **26** and the capacitor **27** is reversed. When the push-button switch **23** is closed a charging current flows through the capacitor **27** and the gate and cathode of the thyristor **21** during the first positive half cycle, so that the thyristor **21** is turned on. When the thyristor is conducting the capacitor **27** is charged by the voltage drop across the gate and cath-

ode of the thyristor **21** and supplies trigger signal during successive positive half cycles.

FIG. **6** shows still another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **3**. The engine stopping device of this embodiment comprises a series circuit of a thyristor **21** and a thyristor **22**. A capacitor **27** is provided to have one of its terminals connected to the gate of the thyristor **21** and to have the other terminal connected to the cathode of the thyristor **21** through a resistor **26** and also connected to the cathode of a diode **24**, whose anode is coupled to the anode of the thyristor **21** by a push-button switch **23**. As the push-button switch **23** is closed, a charging current flows through the capacitor **27** and the gate and cathode of the thyristor **21** during positive half cycle. When the push-button switch **23** is opened, the conducting thyristor **21** charges the capacitor **27** for the subsequent triggering.

FIG. **7** shows still another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **2**. The engine stopping device of this embodiment is similar to that of FIG. **6** except that the diode **24** is connected in the reverse direction and a further diode **33** is provided to have its anode connected to the cathode of the thyristor **21** and to have its cathode connected to the gate of the thyristor **21**. As the push-button switch **23** is closed, the exciter coil **6** provides, in its negative half cycle, a charging current through the diode **33**, the capacitor **27**, the diode **24**, the switch **23** and the resistor **22**, so that the capacitor **27** is charged into a polarity indicated by "+" and "−". With sufficient charge on the capacitor, the thyristor **21** is triggered during the subsequent positive half cycle. After the switch **23** is opened, the conducting thyristor **21** charges the capacitor.

FIG. **8** shows still another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **2**. The thyristor **21** is connected across the power source **6** through a resistor **22** having one end connected to the anode of the thyristor **21**. The thyristor **21** is also provided with a resistor **26** having one end connected to the gate of the thyristor and having the other end connected to one terminal of a capacitor **27**, the other terminal of which is connected to the cathode of the thyristor **21** in the same way as in FIGS. **1–3**. A separate generating coil **31**, which may be provided in the same magneto generator as the exciter coil **6**, is adapted to give initial charge to the capacitor **27** and is connected through a diode **32** and a push-button switch **23** across the capacitor **27**.

When engine stopping operation is initiated by closing the switch **23** the capacitor **27** is charged by the generating coil **31**, and when it is sufficiently charged it supplies a trigger signal to the thyristor **21**. With the thyristor **21** being turned on, the engine stopping device **20** operates to prevent igniting operation of the ignition system.

It is noted that the generating coil **31** may alternatively be connected as to supply a charging current to the capacitor through the primary winding **3***a* and/or the exciter coil **6**, as shown by dotted lines and numerals **31'** and **32'**.

FIG. **9** shows another embodiment of the engine stopping device adapted to control a capacitor discharge ignition system including a capacitor **7** charged by the exciter coil **6** through a diode **9** and discharged through the primary winding **3***a* and a thyristor **8** adapted to be triggered by a trigger circuit not shown. The capacitor **7**, the diode **9** and the thyristor **8** with the trigger circuit from a primary current control circuit **10**.

In the engine stopping device of this embodiment, a capacitor **27** for retaining the thyristor **21** in conductive state has one terminal connected to the gate of the thyristor **21** and has the other terminal connected through a resistor **26** to the cathode of a thyristor **21**. A diode **33** is provided to have its anode connected to the cathode of the thyristor **21** and to have its cathode connected to the gate of the thyristor **21**, thereby forming a path for a charging current together with a push-button switch **23** coupling the junction between the capacitor **27** and the resistor **26** and a negative output terminal of a battery **34** which is employed as a charging power source.

When the push-button switch **23** is closed, the capacitor **27** is charged by the battery through the diode **33** into the polarity indicated by "+" and "−". With sufficient charge on the capacitor, a discharging current tends to flow through the gate and cathode of the thyristor **21** and the resistor **26**. Thus, the thyristor **21** is turned on every time the exciter coil **6** produces a positive output. the voltage drop across the gate and cathode of the thyristor **21** is applied across the series circuit of the capacitor **27** and the resistor **26**. Thus the capacitor **27** is charged to a necessary voltage even after the push-button switch **23** is opened.

The battery may alternatively be so adapted, as shown by dotted lines and the primed numerals, as to charge the capacitor **27** through the primary winding **3***a* and/or the exciter coil **6**.

FIG. **10** shows another embodiment of the engine stopping device similar to that of FIG. **9** except that the diode **33** of FIG. **9** is omitted and the battery **34** is connected in reverse polarity. Initial triggering of the thyristor **21** is achieved when the switch **23** is closed to permit a charging current to charge the capacitor into a polarity opposite to that indicated. After the thyristor **21** is turned on, the capacitor **27** is charged into the polarity indicated by the voltage drop across the gate and cathode of the thyristor **21**. The subsequent triggering of the thyristor **21** is achieved by the discharging current from the capacitor **27**.

Dotted lines and the numeral **34'** indicate an alternative connection of the battery.

It would be apparent to those skilled in the art that the batteries of FIGS. **9** and **10** may be replaced by a series circuit of a generating winding together with a rectifier.

FIG. **11** shows another embodiment of the engine stopping device in which the capacitor **27** for retaining the thyristor in conductive state is adapted to be charged by a secondary **36***b* of a transformer **36** whose primary **36***a* is in series with the thyristor **21**. Initial charging of the capacitor **27** is achieved by a generating coil **31** through the diode **32** and a push-button switch **23**. A resistor **26** is provided to enable application of the voltage on the capacitor **27** to the gate of the thyristor **27**. When the thyristor **21** is turned on, the secondary **36***b* supplies a charging power to charge the capacitor **27** so that the capacitor **27** is ready for the subsequent triggering. The capacitor **27** can be charged to a higher voltage, so that possibility of failure to turn on the thyristor is further reduced.

FIG. **12** shows still another embodiment of the engine stopping device adapted to a capacitor discharge ignition system similar to that of FIG. **3**. The engine stopping device of this embodiment is provided to bypass the trigger signal supplied by the pulse generator **11** to

the gate of the thyristor **8** for discharging the capacitor. To achieve such function, a thyristor **21** is provided to have its anode and cathode connected respectively to the gate and cathode of the thyristor **8**. A capacitor **27** for retaining the thyristor **21** in the conductive state has one of its terminals connected to the cathode of the thyristor **21** and has the other terminal connected through a resistor **26** to the gate of the thyristor **21**. A push-button switch **23** is provided to couple the anode of the thyristor **21** and the junction between the resistor **26** and the capacitor **27**. As the push-button switch **23** is closed, the pulse generator **11** charges the capacitor **27** into the polarity shown, so that the thyristor **21** becomes conductive, and trigger signal to the thyristor **8** is bypassed. Without conduction of the thyristor **8**, the primary current control circuit generally indicated at **10** does not operate and hence ignition does not take place. The conducting thyristor **21** charges the capacitor **27**, so that the thyristor **21** is triggered in the subsequent positive half cycle. This will be repeated as long as the pulse generator **11** produces an output, that is, as long as the engine rotates.

FIG. **13** shows another embodiment of the engine stopping device adaptable to an ignition system of FIG. **12**. The engine stopping device of this embodiment is similar to that of FIG. **11**. The terminals **14***r* and **14***s* may be connected to the gate and cathode of a thyristor of a primary current control circuit **10** such as shown in FIG. **12**. The primary winding **36***a* of a transformer **36** has one end connected to the terminal **14***r* and has the other end connected to the anode of a thyristor **21**, whose cathode is connected to the terminal **14***s*. The secondary winding **36***b* of the transformer **36** has one of its ends connected to the terminal **14***s* and has the other end connected to the anode of a diode **37**, whose cathode is connected through a resistor **26** to the gate of the thyristor **21** and through a capacitor **27** to the cathode of the thyristor **21**. A push-button switch **23** couples the cathode of the diode **37** and the terminal **14***r*. Initial charging of the capacitor **27** necessary to begin conduction of the thyristor **21** is achieved by the pulse generator **11** when the push-button switch **23** is closed. The subsequent charging of the capacitor **27** is achieved by the secondary winding **36***b* which induces a voltage every time the thyristor **21** is turned on.

In the embodiments of FIGS. **12** and **13**, the generating coil **11** for supplying a trigger signal to the thyristor **8** is also used to supply a charging current to the capacitor **27**. But there may be provided a separate generating winding for charging the capacitor **27**, as in FIGS. **8** and **11**.

FIG. **14** shows another embodiment of the engine stopping device similar to that of FIG. **12** except that the positioning of the capacitor **27** and the resistor **26** is reversed and a diode **24** is connected in series with the push-button switch. As the push-button switch **23** is closed a charging current flows through the capacitor **27** and the gate and cathode of the thyristor **21**, so that the thyristor **21** is turned on. Subsequent triggering of the thyristor **21** is effected by the charge on the capacitor **27** which is supplied by the voltage drop across the gate and cathode of the conducting thyristor **21**, in a similar manner as the embodiment of FIG. **10**.

The series circuit of the push-button switch **23** and the diode **24** may be connected as shown by dotted lines and the numerals **23'** and **24'**. With this construction, the initial triggering of the thyristor **21** is achieved when the capacitor **27** is charged to a sufficient voltage.

The embodiment of FIG. **14** (with the solid line) may be so modified that, as in FIG. **9**, a diode (**33**) is provided across the gate and cathode of the thyristor **21** and the direction of the diode **24** is reversed, so that the initial charging current flows through the diode (**33**) so inserted, the reversed diode (**24**), the push-button switch **23** being closed and the coil **11** producing a negative output.

FIG. **15** shows another embodiment of the engine stopping device similar to that of FIG. **12** except that the thyristor **21** is replaced by a transistor **21'** to exemplify that in all of the embodiments described herein any type of switching means may be employed to substitute for the thyristor. The time interval in which the transistor **21'** is kept conductive after release of the push-button switch is determined by the time necessary for discharge of the capacitor **27**.

FIG. **16** shows another embodiment of the engine stopping device adapted to a capacitor discharge ignition system. The engine stopping device of this embodiment comprises a thyristor **21** connected to provide a bypass in shunt with the primary winding **3***a* for the discharging current from the capacitor **7**. More particularly a series circuit of a thyristor **21** and a resistor **22** is connected in parallel with the primary winding **3***a* to form a closed loop with the capacitor **7** and a thyristor **8** for discharging the capacitor **7** at the ignition timing. A push-button switch **23** for initiating the engine stopping operation is connected to couple the cathode of a diode **24** whose anode is connected to the anode of the thyristor **21** and a first end of a resistor **26** the second end of which is connected to the gate of the thyristor **21**. A capacitor **27** for retaining the thyristor **21** in conductive state is connected across the first end of the resistor **26** and the cathode of the thyristor **21**.

When the push-button switch **23** is closed, the capacitor **27** is charged by the discharging current from the capacitor **7** and, when charged to a sufficient level, triggers the thyristor **21**. As the thyristor **21** is conductive, a substantial part of the discharging current from the capacitor **7** flows through the thyristor **21**. After the push-button switch is opened the charging of the capacitor **27** is effected by the voltage drop across the gate and cathode of the conducting thyristor **21** so that the subsequent turn-on of the thyristor **21** is ensured. Thus the ignition of the engine is prevented although the charging and discharging of the capacitor **7** is repeated until the engine is brought to a standstill.

It is noted that the engine stopping device shown in FIG. **6**, **7**, **8** or **11**, or the like may also be used to bypass the discharging current to reduce the primary variation. Furthermore, these engine stopping devices may also be incorporated in other types of ignition systems.

FIG. **17** shows another embodiment of the engine stopping device **20** adapted to a capacitor discharge ignition system. The engine stopping device of this embodiment has a construction similar to that of FIG. **6** except that the diode **24** of FIG. **6** is omitted and that an additional resistor **28** is connected across the gate and cathode of the thyristor **21**. The engine stopping device of the embodiment is adapted to prevent charging of a capacitor **7** when engine is to be stopped.

It is also noted other types of engine stopping devices hereinbefore described may also be utilized to prevent charging of the capacitor **7**.

It is noted that in the various embodiments hereinabove described, various modifications may be made. For instance, the current limiting resistor **22** connecting

in series with the stopping switch such as the thyristor **21** may be replaced by a diode or a plurality of diodes connected in series with each other. The current limiting resistor **22** may be omitted if the stopping switch has a sufficient current capacity or the ignition power source, such as the exciter coil **6** or the ignition coil primary **3***a* has a sufficient internal impedance. Also, the diode **24** connected in series with the push-button switch **23** may be omitted. Moreover the resistor **28**, in FIG. **17**, connected directly across the gate and cathode of the thyristor **21** may be omitted, or in other embodiments, a similar resistor may be provided to protect the thyristor.

FIG. **18** shows another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **2**. The engine stopping device of this embodiment comprises a mechanically driven contact **41** driven by a contact drive **42** which drives the contact in closing position when a push-button or a lever, not shown, is manually operated, and retains the contact in the closing position for a predetermined time after the push-button or the lever is released. Such function is accomplished by a mechanism wherein an arcuate contact is rotated along an arcuate path to be brought to the closing position and a spring is tensioned when a push-button or the like is manually operated, and when the push-button is released the spring slowly rotates the contact in the opposite direction so that a sufficient time elapses before the contact is returned to the opening position.

The closure of the mechanically operated contact **41** yields the same effect as the conduction of the thyristor **21** of FIG. **2**.

The engine stopping device of FIG. **18** may be incorporated in the various ignition systems to bypass various portions of the ignition systems, such as the primary winding, or the capacitor of a capacitor discharge ignition system.

FIG. **19** shows another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **1**. The engine stopping device **20** of this embodiment comprises a mechanically-operated rotatable arcuate contact similar to that of FIG. **18** except that the contact is of a normally-closed type. When the engine is to be stopped the contact **41** is opened, so that the opening-and-closing operation of the breaker **4** becomes ineffective on the ignition coil **3**. This type of normally-closed contact may be used in series with various elements of ignition systems, such as for instance the ignition power source, the primary winding, or the capacitor of a capacitor discharge ignition circuit.

FIG. **20** shows another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **2**. The engine stopping device of this embodiment comprises a mechanically-operated contact **51** of an electromagnetic relay and a magnet coil **57** of the electromagnetic relay for driving the contact into closed position and retaining the contact in the closed position as long as it is energized. The contact **51** is connected in series with the magnet coil **57** so that they form a self-retentive circuit. The initial energization of the magnet coil **57** is achieved by a push-button switch **23** which is connected in parallel with the contact **51**. Closure of the push-button switch **23** and/or the contact **51** provides a low impedance bypass in shunt with the breaker **4**, so that make-and-break operation of the breaker **4** does not cause sufficient variation of the primary current of the ignition coil **3**.

The engine stopping device of FIG. **20** may alternatively be adapted to provide a bypass in shunt with various elements of the ignition system, such as the ignition power source, the primary winding **3***a*, or the capacitor of a capacitor discharge ignition system.

It will also be understood that a normally-closed contact of an electromagnetic relay may be utilized to break a circuit when the engine is to be stopped while a magnet coil with a self-retentive contact is connected to be energized by the ignition power source even after the normally-closed contact is opened. The normally-closed contact may for instance be connected in series with the ignition power source, the primary winding, a capacitor of a capacitor discharge ignition system, or the like.

FIG. **21** shows another embodiment of the engine stopping device adapted to an ignition system similar to that of FIG. **2**. The engine stopping device of this embodiment comprises a normally-open bimetal switch **61** positioned to be heated by a resistor **67** connected in series with the bimetal switch **61**. The initial energization of the resistor **67** is achieved by closing a push-button switch **23** connected in parallel with the bimetal switch **61**. When operated, the engine stopping device of this embodiment provides a low impedance bypass in shunt with the breaker **4**, making ineffective the operation of the breaker.

It will be noted that the engine stopping device similar to that of FIG. **21** may be adapted to provide a bypass in shunt with other circuit elements of an ignition system. Although the bimetal switch itself is shown to constitute a switch to make ineffective the element, a contact driven by a bimetal may be utilized for that purpose. Such a contact may be of a normally-open type where the circuit element is to be bypassed, or of a normally-closed type where the circuit is to be broken. The power source of the heater may be separately provided.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

For instance, in the various embodiment described above, the diode **24** in series with the push-button switch may be omitted. Also, the current limiting resistor **22** may be omitted if the thyristor **21** has a sufficient current capacity or if the ignition power source, the exciter coil **6** or the primary winding **3***a*, has a sufficient internal impedance.

It is also noted that the various engine stopping devices according to the present invention can be adapted to any of the ignition systems illustrated as well as others which are known. For instance the engine stopping device may be adapted to provide a bypass in shunt with a breaker or a semiconductor switch connected in series with a primary winding of an ignition coil to control the primary current.

What is claimed is:

1. An engine stopping device for stopping an internal combustion engine provided with an ignition system energized by a generator driven by the engine, said stopping device comprising a first thyristor for provid-

ing a bypass in shunt with a power source of the ignition system, said thyristor being connected across the ignition power source, a series circuit of a resistor and a capacitor, said series circuit being connected across a gate and cathode of said thyristor so that said capacitor is charged by the voltage drop across the gate and cathode of said thyristor, and a manually-operated self-returning switch which is adapted to couple said ignition power source and the gate of said thyristor so that a trigger signal is supplied to said thyristor when the self-returning switch is operated to stop the engine.

2. An engine stopping device as set forth in claim 1, wherein the ignition system comprises a semiconductor switch for controlling the primary current of the ignition coil and said thyristor is adapted to provide a bypass in shunt with the semiconductor switch.

3. An engine stopping device as set forth in claim 1, wherein the ignition system comprises a second thyristor for controlling the primary current of the ignition coil and said is adapted to provide a bypass across the anode and cathode of the said second thyristor.

4. An engine stopping device as set forth in claim 1, wherein said capacitor is connected through said self-returning switch across said ignition power source.

5. An engine stopping device as set forth in claim 4, further comprising a diode and said capacitor is connected through said diode across said ignition power source.

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